

## **National Ocean Service and Sea Turtles: Habitat Suitability Modeling**

Michael S. Coyne  
Biogeography Program  
Center for Coastal Monitoring and Assessment  
National Ocean Service  
Silver Spring, Maryland

The objectives of this workshop are to (1) review the state of knowledge of marine species (marine mammals and sea turtles) in the Gulf of Mexico protected under the Endangered Species Act and Marine Mammal Protection Act; (2) identify critical information needs for the Minerals Management Service (MMS); and (3) facilitate coordination among various funding agencies.

Within these guidelines, the emphasis of this paper is to review the National Ocean Services' (NOS) involvement in sea turtle research and, in particular, to describe the Biogeography Program's activities as they may help MMS meet the above objectives. Previous workshops have commented on the need to develop a predictive model to quantitatively assess the impact of industrial activities on sea turtle populations in the Northern Gulf (Bjorndal and Bolten, 1990). Therefore, a large portion of this paper will be devoted to a description of the Biogeography Program's expertise in habitat suitability modeling (HSM) which offers an excellent opportunity for meeting this need.

### **NOS Activities**

Historically NOS has played a limited role in sea turtle research and management, although several products have been used extensively by other state and federal agencies and departments. Earliest efforts have included the development of such products as the Gulf of Mexico Coastal and Ocean Zones Strategic Assessment: Data Atlas (NOAA, 1985) which provided descriptions and distributions of loggerhead and Kemp's ridley sea turtles, as well as, several marine mammal species.

More recent sea turtle work has been carried out within the National Marine Sanctuaries Program of NOS. These efforts have primarily focused upon the loggerhead

sea turtle and included tagging and tracking of turtles that utilize Gray's Reef off the coast of Georgia and the Flower Garden Banks off the coast of Texas (Mitchell, in press).

Finally, the Center for Coastal Fisheries and Habitat Research in Beaufort, North Carolina, has recently reorganized into the NOS organization. Previously a part of the National Marine Fisheries Service (NMFS), the Beaufort laboratory has conducted and continues to carry out research in cooperation with NMFS on sea turtles in the Pamlico-Albemarle Estuarine Complex. These efforts have included work on juvenile loggerhead, green, and Kemp's ridley sea turtles. Most notable is an ongoing cooperative effort with local pound fishermen to establish an index-abundance-area to monitor, assess and predict the status of and impacts to sea turtles and their ecosystems (Epperly *et al.*, in press). Additional work has involved the treatment and release of cold-stunned sea turtles and the use of NOAA's CoastWatch sea surface temperature (SST) imagery to help protect overwintering sea turtles during fishing activities off North Carolina and Virginia. A final rule under the Endangered Species Act reduces the area within which Turtle Excluder Devices are required during January 15 – March 15 (FR Vol. 61 Num. 16, pp1846-8). This imagery is being used by other agencies and aquariums to help determine optimal locations along the east coast for returning rehabilitated turtles to the sea.

### **Biogeography Program Activities**

NOS' Biogeography Program is part of the Center for Coastal Monitoring and Assessment within the Centers for Coastal Ocean Science. Historically, the Biogeography Program has had little involvement in sea turtle research or management activities. However, recent development of cutting-edge GIS technologies and modeling techniques have placed the Program in a position well suited to address many issues related to protected species.

A goal of the Biogeography Program is to develop knowledge of living marine resource distributions and ecology throughout the Nation's marine, coastal and estuarine environments to provide managers with an improved ecosystem basis for making decisions. This effort has led to the development of a suite of products which use a continuum of approaches to define bio-physical relationships which differ in data content, complexity, and analytical structure (Figure 1).

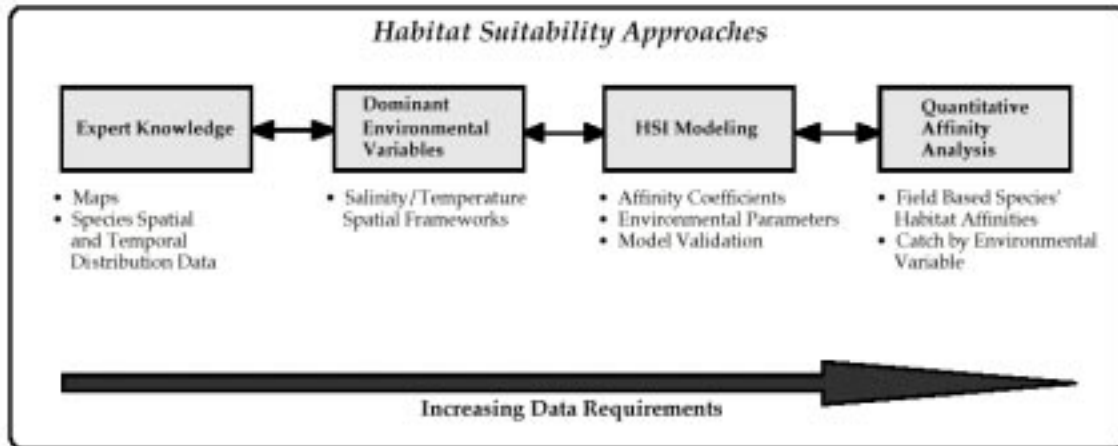


Figure 1. Four approaches to coupling species distribution and habitat.

NOAA's Biogeography Program was a partner with MMS in developing the Gulfwide Information System (GWIS). The objective of GWIS was to develop an authoritative database to be used by MMS, industry and other regulatory and resource protection agencies for oil spill planning and response activities. Environmental sensitivity index maps and biogeographic characterizations were developed for invertebrate, fish, bird and sea turtle species. NOAA's efforts included (1) digital integration of NOAA's Estuarine Living Marine Resources data (ELMR); (2) digital update of selected coastal/marine fishes in the Gulf of Mexico; and (3) a development of a desktop GIS system to organize and analyze the GWIS database.

NOAA's Biogeography Program also has worked cooperatively with NMFS and the regional Fishery Management Councils to meet Essential Fish Habitat requirements of the reauthorized Magnuson-Stevens Fisheries Conservation and Management Act. Products delivered to the Councils included maps and supporting data with spatial and temporal distribution and abundance of high-priority, managed species.

EFH work has helped identify critical information needs, particularly in the Caribbean, and led to an effort to identify and map coral reef and other shallow water habitats in the Caribbean using remote sensing technologies. As such, a Memorandum of Understanding has been developed with the National Park Service to utilize Buck Island National Monument (BUNM) in St. Croix as a test site for the development of coral reef habitat classification scheme for Puerto Rico and the US Virgin Islands. Plans are currently in development to extend this effort to US possessions in the Pacific.

Specific habitat classification efforts at BUNM include a study of resident juvenile hawksbill sea turtles in relation to distribution of prey. Zoanthids have been

identified as a major dietary component of BUNM hawksbills, and as such, the spatial and temporal distribution and abundance of both organisms is being characterized. Additional cooperation with the NPS has led to advanced GIS support for ongoing sea turtle satellite telemetry operations (Hillis-Starr *et al.*, in press). New approaches to spatial analysis of sea turtle tracking data are being developed beyond traditional methods. Efforts are being made to explore new ways of displaying these data and to associate sea turtle tracks with various habitat and environmental parameters.

### **Habitat Suitability Modeling**

As a tool, habitat suitability modeling (HSM) has a lot to offer in terms of research and management decision-making. The underlying approach was introduced by the US Fish and Wildlife Service's Habitat Evaluation Procedures Program, whereby models resulted in a numerical index of habitat suitability. Models were based on the assumption that a positive relationship exists between the index and a habitat's carrying capacity for a given species (Schamberger *et al.*, 1982). Our models depart from the USFWS methods by incorporating a spatial component to produce a view of the relative suitability of locations in geographic space through time. The intent was to develop a simple spatial model using GIS technology that offers estuarine resource managers a habitat assessment capability that can be applied to a wide range of marine species.

Model complexity and structure can vary considerably depending upon data availability and the questions being asked (Figure 2). The simplest models are based upon expert knowledge of a species and its habitat to create simple polygonal maps of spatial and temporal distribution. Slightly more complex models look at species distribution based upon a dominant environmental variable, such as salinity (Bulger *et al.*, 1993; Christensen *et al.*, 1997). Habitat suitability index modeling combines the suitability of several environmental variables using a simple equation, such as a geometric mean (Rubec *et al.*, 1998; Rubec *et al.*, 1999; Coyne *et al.*, in press). Finally, several habitat layers can be combined using a multivariate equation describing a species' relationship to those variables.

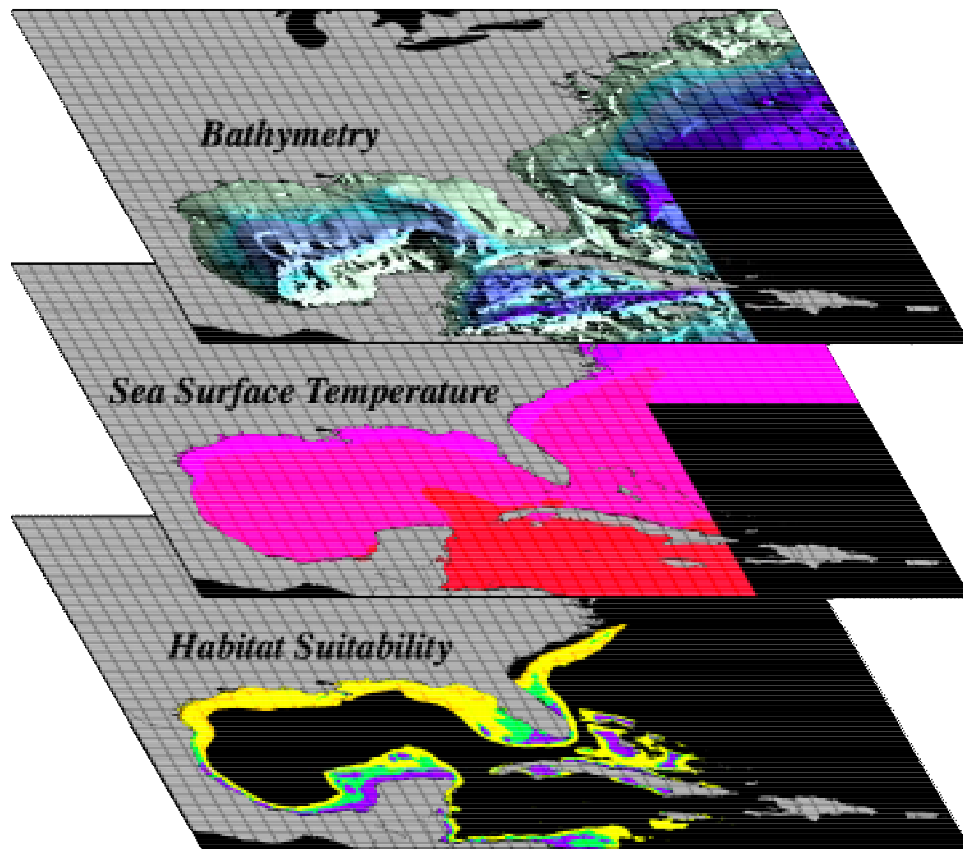


Figure 2. Hypothetical habitat suitability model for Kemp's ridley sea turtles. Predicts potential winter distribution.

## Conclusions

NOS' Biogeography Program's goal to develop knowledge of living marine resource distributions and ecology coincide with MMS' objectives as they relate to protected species. In particular, the Biogeography Program's experience with habitat suitability modeling can serve as an invaluable tool. HSM is well-suited to address the need to develop predictive models to quantitatively assess the impact of industrial activities on sea turtle populations in the Northern Gulf.

## References Cited

- Bulger, A. J., B. P. Hayden, M. E. Monaco, D. M. Nelson and M. G. McCormick-Ray. 1993. Biologically-based estuarine salinity zones derived from a multivariate analysis. *Estuaries* 16:311-22.
- Bjorndal, K. A., and A. B. Bolten. 1990. Goals for sea turtle research in the Gulf of Mexico with respect to the oil and gas industries. *In* SeaTurtles and Marine Mammals of the Gulf of Mexico, Proceedings of a workshop held in New Orleans, August 1-3, 1989. OCS Study 90-0009. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. pp47-58.
- Christensen, J. D., M. E. Monaco and T. A. Lowery. 1997. An index to assess the sensitivity of Gulf of Mexico species to changes in estuarine salinity regimes. *Gulf Research Reports* 9:219-29.
- Coyne, M. S., M. E. Monaco and A. M. Landry, Jr. In Press. Kemp's ridley habitat suitability index model. *In* Proceedings of the 18<sup>th</sup> International Sea Turtle Symposium, Mazatlan, Mexico.
- Epperly, S. P., J. Braun-McNeill and A. L. Bass. In-water population index surveys: North Carolina, USA. *In* Proceedings of the 18<sup>th</sup> International Sea Turtle Symposium, Mazatlan, Mexico.
- Hillis-Starr, Z., M. Coyne and M. Monaco. In Press. Buck Island and back – hawksbill turtles make their move. *In* Proceedings of the 19<sup>th</sup> Annual Symposium on Sea Turtle Conservation and Biology, South Padre Island, Texas.
- Mitchell, S. V. In Press. Loggerhead sea turtle (*Caretta caretta*) satellite tagging project. *In* Proceedings of the 18<sup>th</sup> International Sea Turtle Symposium, Mazatlan, Mexico.
- National Oceanic and Atmospheric Administration. 1985. Gulf of Mexico Coastal and Ocean Zones Strategic Assessment: Data Atlas. Strategic Assessment Branch, Ocean Assessments Division, office of Oceanography and Marine Assessment, National Ocean Service and Southeast Fisheries Center, National Marine Fisheries Service.

Rubec, P. J., J. C. W. Bexley, H. Norris, M. S. Coyne, M. E. Monaco, S. G. Smith and J. S. Ault. 1999. Suitability modeling to delineate habitat essential to sustainable fisheries. American Fisheries Society Symposium 22:108-33.

Rubec, P. J., M. S. Coyne, R. H. McMichael, Jr., and M. E. Monaco. 1998. Spatial methods being developed to determine essential fish habitat. Fisheries 23:21-5.

Schamberger, M., A. H. Farmer and J. W. Terrel. 1982. Habitat suitability index models: Introduction. USFWS. FWS/OBS-82/10: 2pp.